Ch 9 Stoichiometry

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$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

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a. $3.0\ mol\ O_2 \rightarrow$? ? ?

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a. $3.0\ mol\ O_2 \rightarrow 4.0\ mol\ NH_3$? ?

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a. $3.0\ mol\ O_2 \rightarrow 4.0\ mol\ NH_3$ $\quad 2.0\ mol\ N_2$ $\quad ?$

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a. $3.0\ mol\ O_2 \rightarrow 4.0\ mol\ NH_3$ $2.0\ mol\ N_2$ $6.0\ mol\ H_2O$

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b $8.0\ mol\ NH_3$? ? ?

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$36.3\ mol\ N_2$? ? ?

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$30.3\,mol\,N_2 \times \frac{4\,mol\,NH_3}{2\,mol\,N_2} = 60.6\,mol\,NH_3$

$30.3\,mol\,N_2$? ? ?

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Molar Ratio

Conversion made from coefficients in Rxn to convert from one React/Prod to another.

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Conversion made from coefficients in Rxn to convert from one React/Prod to another.

$30.3\,mol\,N_2 \times \frac{3\,mol\,O_2}{2\,mol\,N_2} = ?$

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Conversion made from coefficients in Rxn to convert from one React/Prod to another.

$30.3\,mol\,N_2 \times \frac{4\,mol\,NH_3}{2\,mol\,N_2} = 60.6\,mol\,NH_3$

$30.3\,mol\,N_2 \times \frac{3\,mol\,O_2}{2\,mol\,N_2} = ? = 45.5\,mol\,O_2$

$$2N_2O_5 \rightarrow 2N_2 + 5O_2$$

If 45.7 mol of O_2 are produced, how many mol of N_2O_5 are used?

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$$45.7\text{ mol } O_2 \times \frac{2\text{ mol } N_2O_5}{5\text{ mol } O_2}$$

$$2N_2O_5 \rightarrow 2N_2 + 5O_2$$

If 45.7 mol of O_2 are produced, how many mol of N_2O_5 are used?

$$45.7 \text{ mol } O_2 \times \frac{2 \text{ mol } N_2O_5}{5 \text{ mol } O_2} = \boxed{18.3 \text{ mol } N_2O_5}$$

$Cu(NO_3)_2 + NaOH \longrightarrow$

If 34.8 g of NaOH react w/ an excess of $Cu(NO_3)_2$, How many mol of ppt will form? g of ppt?

$Cu(NO_3)_2 + 2NaOH \longrightarrow Cu(OH)_2 \downarrow + 2NaNO_3$

If 34.8 g of NaOH react w/ an excess of $Cu(NO_3)_2$, how many mol of ppt will form? g of ppt?

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If 34.8 g of NaOH React w/ an excess of $Cu(NO_3)_2$, How many mol of ppt will form? g of ppt?

$34.8\,g\,NaOH \times \frac{1\,mol\,NaOH}{40.0\,g\,NaOH}$

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$$0.435\,\text{mol } Cu(OH)_2 \times \frac{97.5\,\text{g } Cu(OH)_2}{1\,\text{mol } Cu(OH)_2} = 42.4\,\text{g } Cu(OH)_2$$

$$Ag_2CO_3 \longrightarrow Ag_2O + CO_2$$

If 23.6 g of carbon dioxide are given off when Ag_2CO_3 (completely) decomposes, what mass of silver oxide remains?

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If 23.6 g of carbon dioxide are given off when Ag_2CO_3 (completely) decomposes, what mass of silver oxide remains?

$$23.6\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44.0\ g\ CO_2} \times \frac{1\ mol\ Ag_2O}{1\ mol\ CO_2} \times \frac{231.8\ g\ Ag_2O}{1\ mol\ Ag_2O}$$

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$$= 124\ g\ Ag_2O$$

Limiting Reactant

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$$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$$

If 27.5 g Al react
w/ an excess of $FeCl_2$,
what mass of Fe is produced?

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27.5 g Al

30.3 g $FeCl_2$

Limiting Reactant

$$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$$

1) Convert Both moles

$27.5\ g\ Al \times \frac{1\ mol\ Al}{27.0\ g\ Al} =$ 1.02 mol Al have

$30.3\ g\ FeCl_2 \times \frac{1\ mol\ FeCl_2}{126.8\ g\ FeCl_2} =$ 0.239 mol $FeCl_2$ have

Limiting Reactant

$$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$$

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1. Convert to moles

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$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$

27.5g 30.3g

1. Convert to moles

$27.5\,g\,Al \times \frac{1\,mol\,Al}{27.0\,g\,Al} = 1.02\,mol\,Al$ have

$30.3\,g\,FeCl_2 \times \frac{1\,mol\,FeCl_2}{126.8\,g\,FeCl_2} = 0.239\,mol\,FeCl_2$ have

$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$

1.02 mol Al, 0.239 mol $FeCl_2$

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1.02 mol Al, 0.239 mol $FeCl_2$

1. Convert to moles

$27.5\,g\,Al \times \frac{1\,mol\,Al}{27.0\,g\,Al} = 1.02\,mol\,Al$ have

2. Pick 1 Reactant & use a Molar Ratio to see how much of the other Reactant is needed.

$30.3\,g\,FeCl_2 \times \frac{1\,mol\,FeCl_2}{126.8\,g\,FeCl_2} = 0.239\,mol\,FeCl_2$ have

$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$

1.02 mol Al, 0.239 mol $FeCl_2$

1. Convert to moles

$27.5\,g\,Al \times \frac{1\,mol\,Al}{27.0\,g\,Al} = 1.02\,mol\,Al$ (have) $\times \frac{3\,mol\,FeCl_2}{2\,mol\,Al} = 1.53\,mol\,FeCl_2$ (need)

2. Pick 1 Reactant & use a Molar Ratio to see how much of the other Reactant is needed.

$30.3\,g\,FeCl_2 \times \frac{1\,mol\,FeCl_2}{126.8\,g\,FeCl_2} = 0.239\,mol\,FeCl_2$ (have)

$2Al + 3FeCl_2 \rightarrow 2AlCl_3 + 3Fe$

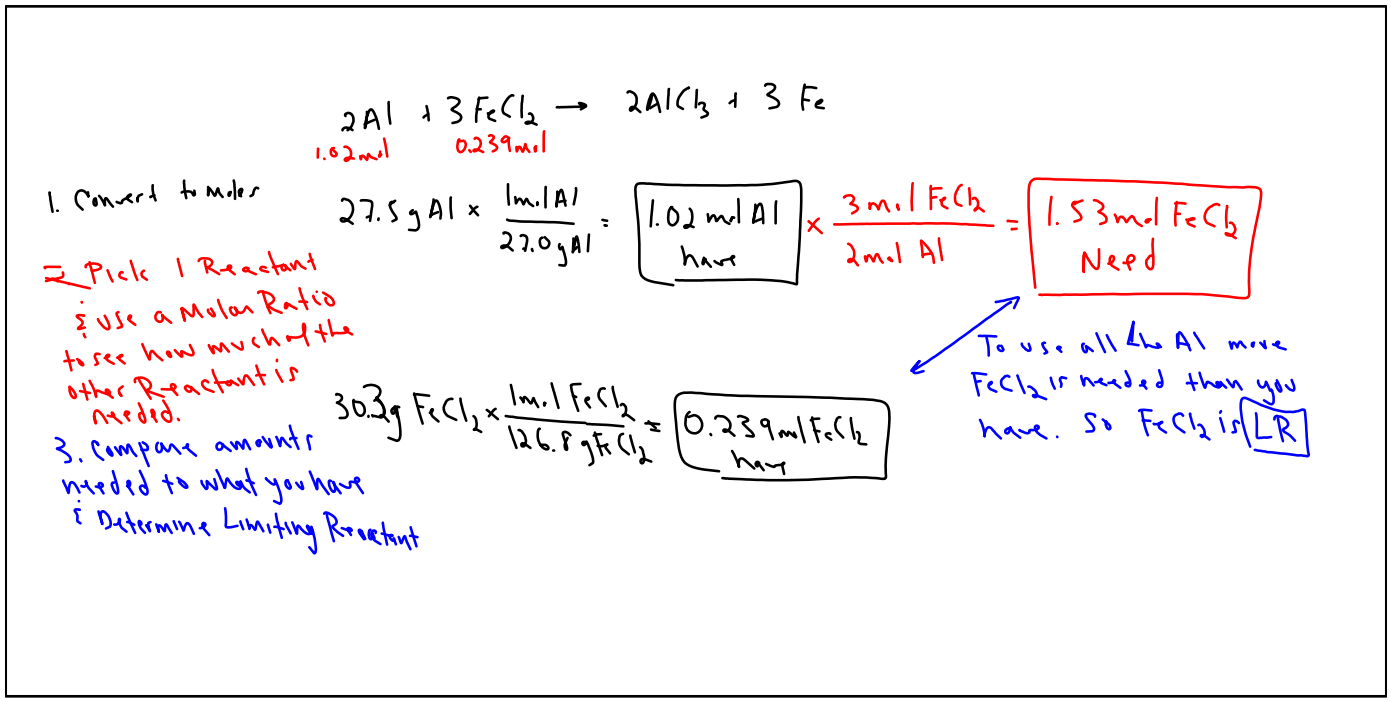
(1.02 mol Al; 0.239 mol $FeCl_2$)

1. Convert to moles

$27.5\,g\,Al \times \frac{1\,mol\,Al}{27.0\,g\,Al} = 1.02\,mol\,Al$ have $\times \frac{3\,mol\,FeCl_2}{2\,mol\,Al} = 1.53\,mol\,FeCl_2$ Need

$30.3\,g\,FeCl_2 \times \frac{1\,mol\,FeCl_2}{126.8\,g\,FeCl_2} = 0.239\,mol\,FeCl_2$ have

2. Pick 1 Reactant
   - Use a Molar Ratio to see how much of the other Reactant is needed.
3. Compare amounts needed to what you have
   - Determine Limiting Reactant


2Al + 3FeCl2 → 2AlCl3 + 3Fe
1.02 mol
0.239 mol
1. Convert to moles
27.5 g Al × 1 mol Al / 27.0 g Al = 1.02 mol Al have
× 3 mol FeCl2 / 2 mol Al = 1.53 mol FeCl2 Need
30.3 g FeCl2 × 1 mol FeCl2 / 126.8 g FeCl2 = 0.239 mol FeCl2 have
2. Pick 1 Reactant & use a Molar Ratio to see how much of the other Reactant is needed.
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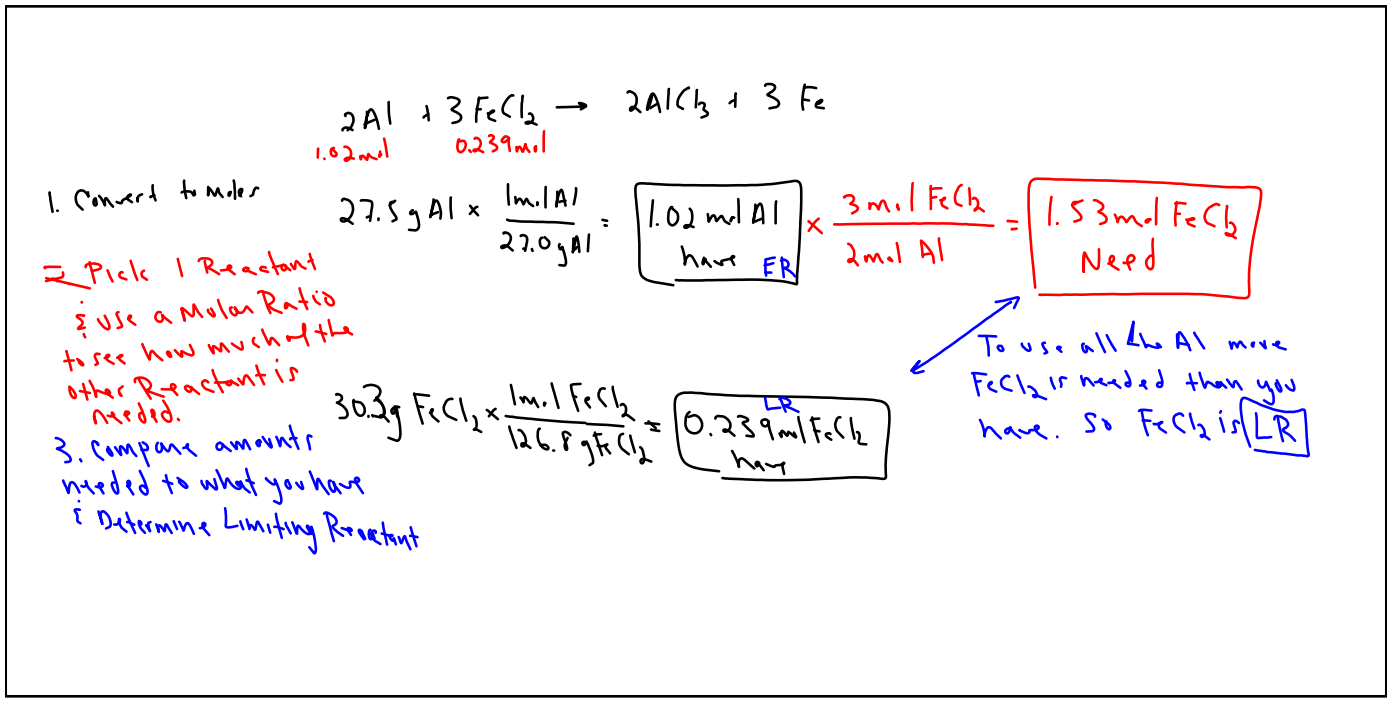
To use all the Al more FeCl2 is needed than you have. So FeCl2 is LR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1.02 mol
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1. Convert to moles
27.5 g Al × 1 mol Al / 27.0 g Al = 1.02 mol Al have ER × 3 mol FeCl2 / 2 mol Al = 1.53 mol FeCl2 Need
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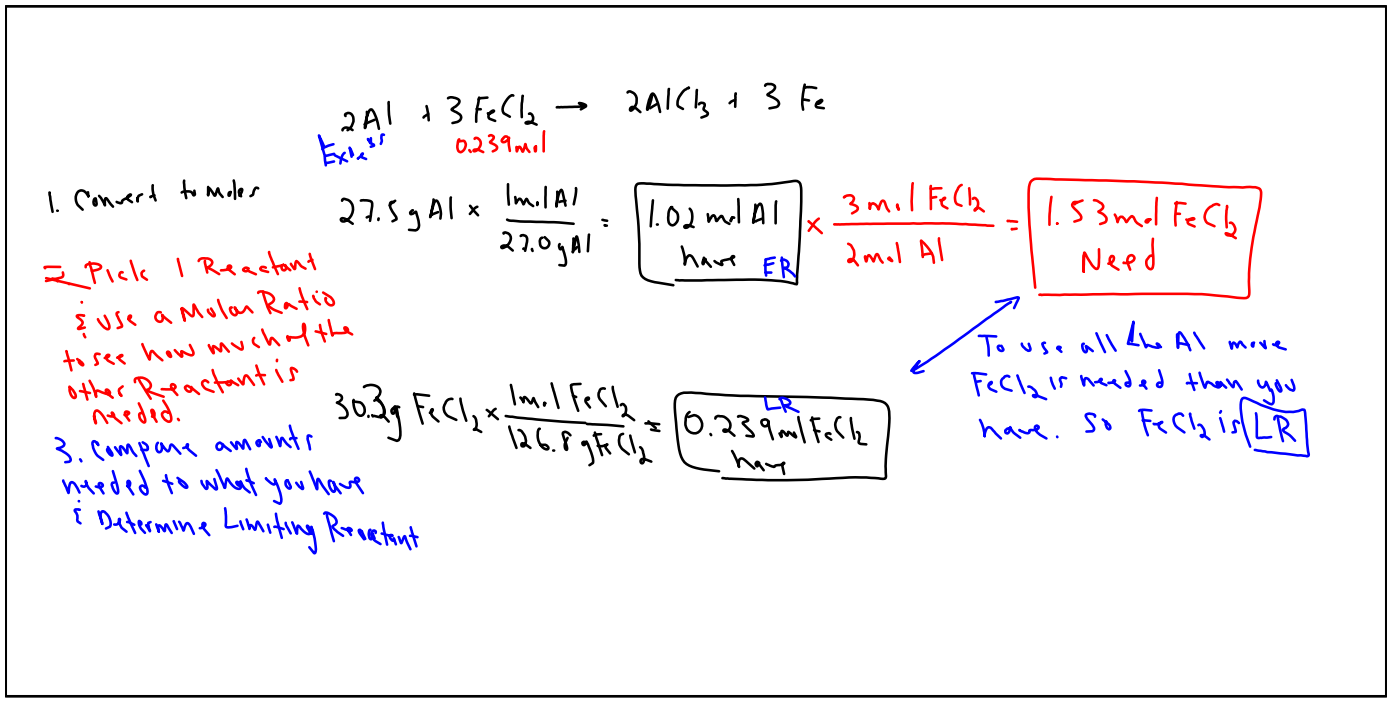
2Al + 3FeCl2 → 2AlCl3 + 3Fe
Excess
0.239mol
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27.5gAl × 1mol Al / 27.0gAl = 1.02 mol Al have ER × 3mol FeCl2 / 2mol Al = 1.53mol FeCl2 Need
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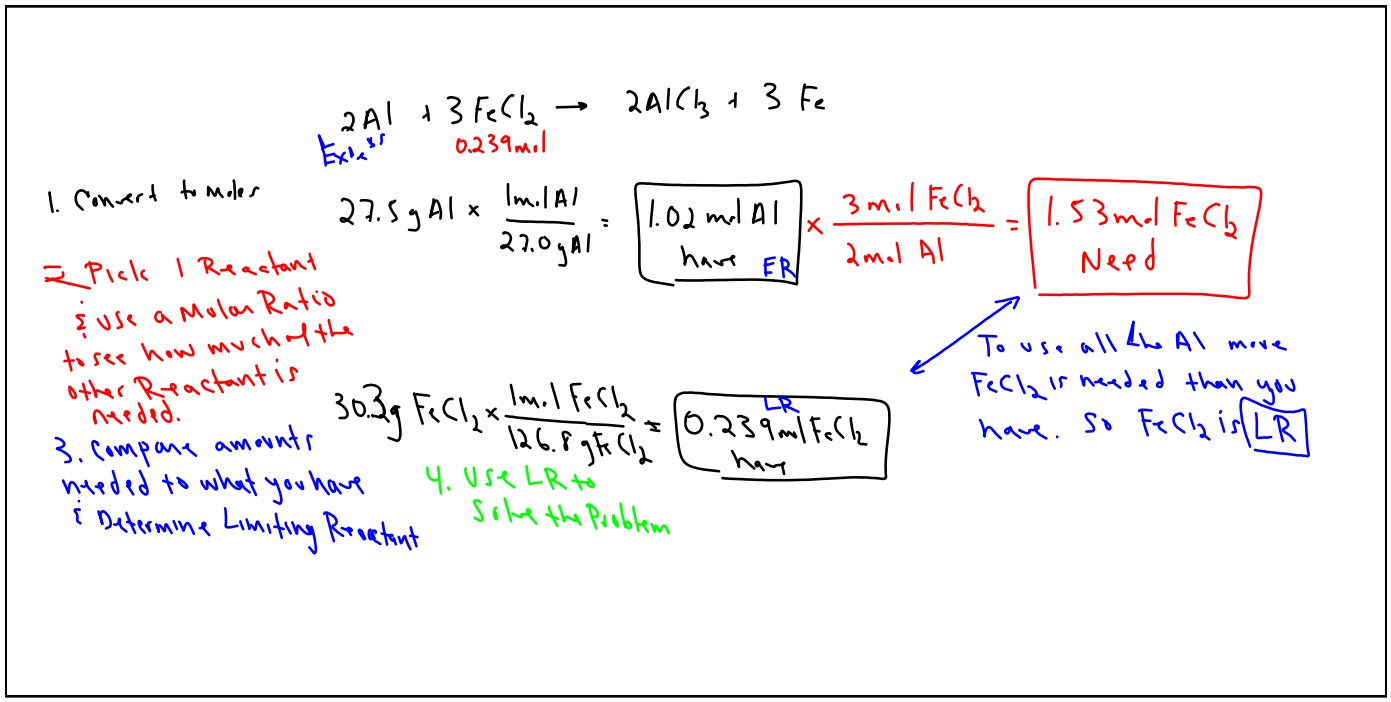
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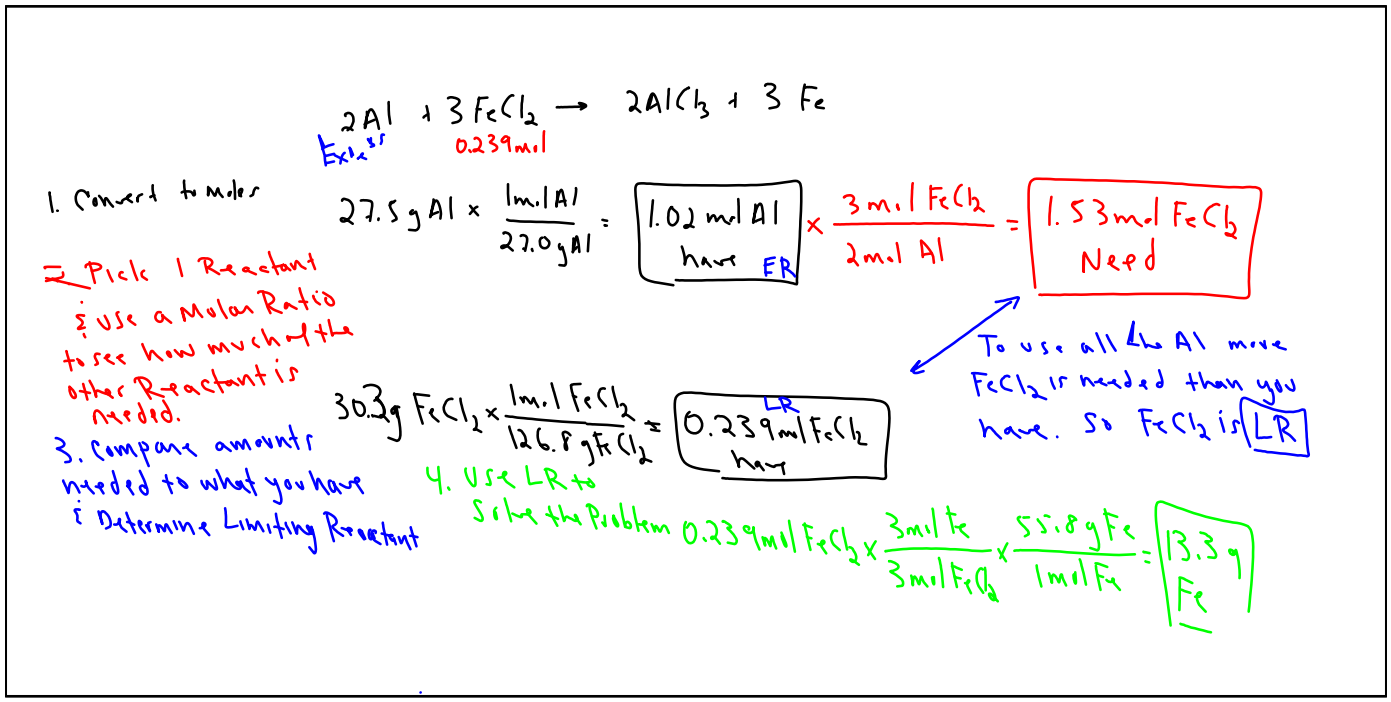
4. Use LR to Solve the Problem
To use all the Al more FeCl2 is needed than you have. So FeCl2 is LR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30.3g FeCl2 × 1mol FeCl2 / 126.8g FeCl2 = 0.239mol FeCl2 have
LR
To use all the Al more FeCl2 is needed than you have. So FeCl2 is LR
4. Use LR to Solve the Problem
0.239mol FeCl2 × 3mol Fe / 3mol FeCl2 × 55.8g Fe / 1mol Fe = 13.3 g Fe

Percent yield

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actual yield - obtained through experimentation

Percent yield

actual yield - obtained through experimentation

theoretical yield.

Percent yield

actual yield - obtained through experimentation

theoretical yield - predicted/calculated yield based on stoichiometry

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actual yield - obtained through experimentation ← Typically given

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actual yield - obtained through experimentation ← Typically given

theoretical yield - predicted/calculated yield based on stoichiometry ← calculated By you,

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

If 16.8 g of $AgNO_3$ R and
w/ an excess of $CaCl_2$,
what is % yield if only
2.31 g of ppt are produced?

$2AgNO_3 + CaCl_2 \longrightarrow 2AgCl + Ca(NO_3)_2$

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$2AgNO_3 + CaCl_2 \longrightarrow 2AgCl\downarrow + Ca(NO_3)_2$

16.8 g have — excess — 2.31 g made (actual yield)

$$16.8\ g\ AgNO_3 \times \frac{1\ mol\ AgNO_3}{170\ g\ AgNO_3} \times \frac{1\ mol\ AgCl}{1\ mol\ AgNO_3} \times \frac{143.5\ g\ AgCl}{1\ mol\ AgCl} =$$

If 16.8 g of $AgNO_3$ React w/ an excess of $CaCl_2$, what is % yield if only 2.31 g of ppt are produced?

$2AgNO_3 + CaCl_2 \longrightarrow 2AgCl\downarrow + Ca(NO_3)_2$

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Theoretical yield

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$2AgNO_3 + CaCl_2 \longrightarrow 2AgCl\downarrow + Ca(NO_3)_2$

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Theoretical yield

$$\%\ yield = \frac{2.31\ g\ AgCl}{14.2\ g\ AgCl} \times 100\% = \boxed{16.3\%}$$